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Review Article

HERBAL WEALTH FOR HEPATOTOXICITY: A REVIEW

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ABSTRACT

Liver is the prominent organ of biliary system and it is one of the vital organs involved in various responsibilities required to maintain homeostasis of our body. It has got its own vital role in the physiological system. Metabolism of ingested substances such as carbohydrates, lipids, proteins, blood coagulation, and immunomodulation are the primary functions of the liver. 1 out of 3 peoples are affected by liver diseases. Around more than 2000 billion people alive with affecting hepatotoxicity. The synthetic drugs to treat liver disorders also cause further damage to the liver. Hence, the popularity of herbal drugs is increasing and their use is wide-spread. Numerous medicinal plants are available to treat hepatoxicity some of the plants are *Abrus precatorius*, *Abutilon indicum*, *Allium cepa*, *Andrographis paniculata*, *Averrhoa carambola*, *Azadirachta indica*, *Boerhavia diffusa*, *Cassia fistula*, *Curcuma longa*, *Daucus carota*, *Eclipta prostrata*, *Ficus carica*, *Homalomena aromatica*, *Indigofera barberi*, *Lawsonia inermis*, *Plumbago zylanica*, *Tamarindus indicus.* The hepatotoxicy of various plants is evaluated by various liver cell injury inducing agents *viz*., chemicals such as carbon tetrachloride, ethanol; drugs such as ibuprofen, paracetamol, thioacetamide, ranitidine, anti-tubercular drugs; metals like cadmium, lead and the activity was estimated by parameters like serum glutamic pyruvic transaminase, serum glutamic oxaloacetic transaminase, aspartate amino transaminase, alkaline phosphatase, alanine amino transaminase, total cholesterol and bilirubin levels. The present review focused on different medicinal plants that have been tested in hepatotoxicity in animal models.

Keywords: Liver, Hepatotoxicity, Herbal drugs, *Abrus precatorius*, *Curcuma longa*, Paracetamol, Serum glutamic pyruvic transaminase, Serum glutamic oxaloacetic transaminase.

INTRODUCTION

Liver is main organ of biliary system and it is one of the vital organs involved in various responsibilities required to maintain important homeostasis of the body. It has got its own importance in the physiological system. Metabolism of ingested substances like carbohydrates, lipids, proteins, blood coagulation and immunomodulation are the primary functions of the liver. One out of three peoples are affected by liver diseases. Around more than 2000 billion people alive with affecting hepatotoxicity. Hepatotoxicity is the major health problem in world. Hepatotoxicity is the capacity of chemicals, drugs or other exposure to produce injury to the liver [1].

Liver damage is always associated with cellular necrosis; reduce in tissue lipid peroxidation and depletion in the tissue glutathione (GSH) levels. In addition serum levels of many biochemical markers like aspartate amino transaminase (AST), alanine amino transaminase (ALT), serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), total cholesterol, and total bilirubin (TB) are evaluated.

There are several reasons known to cause moderate to severe hepatic complications. Some liver complications emerge out as results of socially unaccepted life style of the individuals. On the other hand, some other liver toxicities result due to unavoidable circumstances. Irrespective of the reason for the toxicity, the subject has to suffer from several systemic complications, which throw the subject toward the danger edge of the life. Thus, to maintain a healthy liver is a crucial factor for overall health. However, it is continuously exposed to environmental toxins, abused by poor drug habits, alcohol, prescribed and over-the-counter drug, which can eventually lead to various liver ailment like alcoholic liver disease, cirrhosis and hepatitis [2,3]. Liver diseases are some of the fatal disease in the world today. It shows a serious challenge to international public health. Compared with modern medicines plant based preparations are employed for the treatment of liver disorders [4,5].

Herbal therapy has been criticized because medicinal plants have not been tested for efficacy testing should be performed on the entire herb or only on its active constituents. Few therapies depend on the actions of several herbs working together. Plants are important sources of medicines, in all countries plant-based traditional medicines are used for healthcare. World Health Organization (WHO) estimated that around 80% of the world's population depends on medicinal plants as their primary health care source. The WHO has reported around 21,000 plants are used for medicinal purpose. Of which 2500 species are in India, among these 150 species are used commercially on a fairly large scale. In a world, India is the largest producer of medicinal herbs and is called as a botanical garden of the world [6].

Abrus precatorius

Hydroalcoholic extract of *A. precatorius* (Fabaceae) seed was evaluated against paracetamol induce hepatotoxicity in rats. The hepatoprotective effects of *A. precatorius* noted as a result of the some of its constituents that have antioxidant properties, such as gallic acid, glycyrrhizin, trigonelline. Protective effect of *A. precatorius is shown* by lowering the elevated level of ALT, AST, alkaline phosphatase (ALP) and bilirubin. The effects produce comparable with standard drug silymarin [7].

Abutilon indicum

The aqueous extract of *A. indicum* (Malvacea) leaves were tested for hepatoprotective activity against carbon tetrachloride and paracetamol-induced hepatotoxicity in rats. *A. indicum* exhibited significant hepatoprotective activity by reducing carbon tetrachloride and paracetamol induced change in bio-chemical parameters that was evident by enzymatic examination. The effects produce comparable with standard drug silymarin [8,9].

Achyranthes aspera

Hydroalcoholic extract of *A. aspera* (Amaranthaceae) seed was evaluated against carbon tetrachloride induce hepatotoxicity in rats. Protective effect of *A. precatorius* by lowering the elevated level of ALT,

AST, ALP, total protein and TB. The effects produce comparable with standard drug silymarin [10].

Albizia procera
Ethanolic extract of *A. procera* (Mimosaceae) aerial parts was evaluated against Paracetamol induce hepatotoxicity in rats. Protective effect of *A. procera* is shown by lowering the elevated level of ALT, AST, ALP and TB. The effects produce comparable with standard drug silymarin [11].

Allium cepa
Hepatoprotective activity of *A. cepa* (Alliaceae) Bulb extract was reported by inducing hepatotoxicity with cadmium (Cd) in rats. It shows significant protective effect by lowering the ALT, AST, ALP, total protein and TB. The effects produced were comparable to that of a standard hepatoprotective agent [12].

Amaranthus tricolor
Hepatoprotective activity of aqueous extract of *A. tricolor* root (Amaranthaceae) was reported by inducing hepatotoxicity with paracetamol in rats. *A. tricolor* show sigmificant hepatoprotective activity by decreasing the serum enzymatic levels of SGOT, SGPT, ALP and TB. The effects produce comparable with standard drug silymarin [13].

Andrographis paniculata
The aqueous extract of *A. paniculata* (Acanthaceae) whole plant was tested for hepatoprotective activity against carbon tetrachloride and ethanol-induced hepatotoxicity in rats. *A. paniculata* showed significant hepatoprotective activity against carbon tetrachloride and ethanol comparable with the standard silymarin. It shows decreasing the serum enzymatic level of SGPT, SGOT, ALP total protein and TB. Histopathological studies revealed that concurrent administration of the extract exhibited a protective effect in the liver [14,15].

Averrhoa carambola
Ethanolic extract of *A. carambola* (Averrhoaceae) stem was evaluated against carbon tetrachloride induce hepatotoxicity in rats. It shows significant protective effect by lowering the ALT, AST, ALP. The effects produced were comparable with that of a standard hepatoprotective agent [16].

Azadirachta indica
Hydroalcoholic extract of *A. indica* (Meliaceae) leaves were evaluated against carbon tetrachloride induce hepatotoxicity in rats. Protective effect of *A. indica* is shown by lowering the elevated level of SGOT, SGPT, and ALP. The effects produce comparable with standard drug silymarin [17].

Bauhinia racemosa
Aqueous and ethanolic extracts of *B. racemosa* (Caesalpiniaceae) stem bark was evaluated against carbon tetrachloride induced hepatotoxicity in rats. Protective effect of *B. racemosa* is shown by lowering the elevated level of SGOT, SGPT, and ALP and TB. The effects produce comparable with standard drug silymarin [18].

Blumea mollis
The methanolic extract of *B. mollis* (Asteraceae) leaves tested for hepatoprotective activity against paracetamol-induced hepatotoxicity in rats. *B. mollis* showed significant hepatoprotective activity against carbon tetrachloride and paracetamol, comparable with the standard silymarin. It shows a decrease in the serum enzymatic level of SGOT, SGPT, ALP and TB [19].

Boerhavia diffusa
Hepatoprotective activity of hydroalcoholic extract of *B. diffusa* root and aerial parts (Nyctaginaceaee) was reported by inducing hepatotoxicity with ibuprofen in rats. It shows a decrease in the serum enzymatic level of ALT, AST, ALP total protein and TB. The effects produce comparable with standard drug silymarin [20].

Bridelia retusa
The aqueous and ethanolic extracts of *B. retusa* (Euphorbiaceae) bark was evaluated against carbon tetrachloride induce hepatotoxicity in female mice. Protective effect of *B. retusa* is shown by lowering the elevated level of ALT and lactate dehydrogenase, AST and alkaline phosphatase (ALP). The effects produced were comparable to that of a standard hepatoprotective agent [21].

Butea monosperma
Hydroalcoholic extract of *B. monosperma* (Fabaceae) stem bark was evaluated against carbon tetrachloride induced hepatotoxicity in rats. Protective effect of *B. monosperma* is shown by lowering the elevated level of SGOT, SGPT, ALP, TB and direct bilirubin (DB). The effects produced were comparable to that of a standard hepatoprotective agent [22].

Calycopteris floribumda
Methanolic extract of *C. floribumda* (Combretaceae) stem was evaluated against carbon tetrachloride induced hepatotoxicity in rats. Protective effect of *C. floribumda* show by lowering the elevated level of SGOT, SGPT, ALP and TB. The effects produced were comparable with standard drug silymarin [23].

Canna indica
Methanolic extract of *C. indica* (Cannaceae) aerial parts was evaluated against carbon tetrachloride induce hepatotoxicity in rats. Protective effect of *C. indica* is shown by lowering the elevated level of SGPT, SGOT and TB. The effects produced were comparable with standard drug silymarin [24].

Cansjera rheedii
Ethanolic extract of *C. rheedii* (Opiliaceae) whole plant was evaluated against paracetamol induced hepatotoxicity in rats. Protective effect of *C. rheedii* show by lowering the elevated level of SGOT, SGPT, ALP, gamma glutamate transpeptidase, TB and total protein. The effects produced were comparable to that of a standard hepatoprotective agent [25].

Carthamus tinctorius
Carthamus red was isolated from the sodium bicarbonate extract of *C. tinctorius* (Asteraceae) safflower was evaluated against carbon tetrachloride induce hepatotoxicity in rats. It shows decreasing the serum enzymatic level of ALT, AST, ALP and total protein. The effects produce comparable with standard drug silymarin [26].

Cassia fistula
Methanolic extract of *C. fistula* (Caesalpinaceae) seeds was prepared and tested for its hepatoprotective effect against paracetamol-induced hepatitis in rats. Protective effect of *C. fistula* show by lowering the elevated level of SGOT, SGPT and bilirubin. The effects produce comparable with standard drug Liv-52 [27].

Centella asiatica
Aqueous extract of *C. asiatica* (Apiaceae) whole plant was prepared and tested for its hepatoprotective effect against carbon tetrachloride induced hepatitis in rats. It shows decreasing the serum enzymatic level of AST, ALT, TB and total protein. The effects produced were comparable to that of a standard hepatoprotective agent [28].

Citrullus colocynthis
Alcoholic extract of *C. colocynthis* (Cucurbitaceae) whole plant evaluated against carbon tetrachloride induce hepatotoxicity in rats. It shows a decrease in the serum enzymatic level of ALP, AST and ALT. The effects produced were comparable with standard drug silymarin [29].

Cryptolepis buchananii
Hepatoprotective activity of ethanolic extract of *C. buchananii* leaves (Periplocaceaee) was reported by inducing hepatotoxicity with

acetaminophen-induced liver injury in rats. Protective effect of *C. buchananii* detected by lowering the elevated level of SGOT, SGPT, ALP, total protein and TB. The effects produced were comparable with standard drug silymarin [30].

Curcuma longa

Alcoholic extract of *C. longa* (Zingiberaceae) tubers evaluated against lead acetate induce hepatotoxicity in rats. It shows decreasing the serum enzymatic level of ALT, AST and ALP. The effects produced were comparable to that of a standard hepatoprotective agent [31].

Cuscuta reflexa

Hydroalcoholic extract of *C. reflexa* (Cuscutaceae) whole plant against paracetamol induce hepatotoxicity in rats. It shows decreasing the serum enzymatic level of ALT, AST, ALP, total serum protein and TB. The effects produced were comparable with standard drug silymarin [32].

Daucus carota

Methanoic extract of *D. carota* (Apiaceae) root tubers was prepared and tested for its hepatoprotective effect against paracetamol-induced hepatitis in rats. Protective effect of *D. carota* shown by lowering the elevated level of SGOT, SGPT, ALP and TB. The effects produced were comparable with standard drug silymarin [33].

Decalepis hamiltonii

Methanolic extract of *D. hamiltonii* (Periplocaceae) root was reported by inducing hepatotoxicity with acetaminophen-induced hepatic injury in rats. Protective effect of *D. hamiltonii* show by lowering the elevated level of serum ALT, AST, ALP and bilirubin. The effects produced were comparable with standard drug silymarin [34].

Ecbolium viride

Methanolic extract of *E. viride* (Acanthaceae) root was tested for hepatoprotective activity against carbon tetrachloride induced hepatotoxicity in rats. It show alteration in the levels of biochemical markers of hepatic damage like SGOT, SGPT, ALP, triglycerides, TB and other proteins. The effects produced were comparable with standard drug silymarin [35].

Eclipta prostrata

E. prostrata (Asteraceae) were studied on hepatitis induced by carbon tetrachloride in mice. Hepatoprotective activity was monitored by estimating the serum transaminases (SGOT and SGPT) levels and histopathological changes in the liver of experimental animals. The results produced were comparable to that of a standard hepatoprotective agent [36].

Eclipta alba

Aqueous leaf extract of *E. alba* (Asteraceae) was tested for hepatoprotective activity against carbon tetrachloride and paracetamol-induced hepatotoxicity in rats. It shows decreasing the serum enzymatic level of ALT, AST and ALP. Standard drug silymarin are used to compare the results of parameters [37,38].

Euphorbia hirta

The anti-hepatotoxic effect of *E. hirta* (Euphoribaceae) whole plant alcoholic and aqueous extracts were evaluated in experimental models of liver injury in rats induced by carbon tetrachloride or paracetamol. The hepatic dysfunction was accessed by determining different biochemical parameters in serum the activities of enzymes like ALP, AST, ALT, bilirubin was evaluated. The effects produced were comparable with standard drug silymarin [39].

Ficus carica

The effect of *F. carica* (Moraceae) leaf extract against carbon tetrachloride induced liver damage. The evaluation markers used were ALT and AST. The effects produced were comparable to that of a standard hepatoprotective agent [40].

Flacourtia indica

The protective effect of *F. indica* was evaluated in carbon tetrachloride induced hepatotoxicity. This study revealed that the aqueous extract of *F. indica* (Flacourtiaceae) leaf exerted hepatoprotective effect. There was a significant decrease in ALT, AST, ALP, total serum protein and TB. The effects produced were comparable to that of a standard hepatoprotective agent [41].

Flaveria trinervia

F. trinervia (Asteraceae) is the protective effect of methanolic extract of whole herb against liver damage was evaluated in ethanol-induced hepatotoxicity in rats. The results showed that the treatment of methanolic extract of *F. trinervia* significantly, lowered the serum enzymatic levels of ALT, AST, ALP, TB and DB. The effects produced were comparable to that of a standard silymarin [42].

Hemidesmus indicus

The hepatoprotective activity of the methanolic root extract of *H. indicus* (Periplocaceae) was studied by estimating serum enzyme activities of SGPT, SGOT, ALP, TB and DB. The treatment with methanolic root extract of *H. indicus* showed dependent reduction of carbon tetrachloride or paracetamol-induced elevated serum levels of enzyme activities with parallel increase in TB and DB, indicating the extract could preserve the normal function status of the liver. The effects produced were comparable to that of a standard silymarin [43].

Homalomena aromatica

The protective effect of *H. aromatica* (Araceae) dried rhizomes were evaluated in carbon tetrachloride induced hepatotoxicity. The estimation of liver weight and blood parameters consist of SGOT, SGPT, ALT, AST, ALP, total serum protein, albumin and TB are performed. This study revealed that the ethanolic extract of *H. aromatica* dried rhizomes exerted hepatoprotective effect. The effects produced were comparable to that of a standard drug silymarin [44].

Indigofera barberi

The hepatoprotective activity of the *I. barberi* (Fabaceae) aerial parts against D-Galactosamine induced hepatic toxicity in rats. The degree of protection was measured by using biochemical parameters like ALT, AST, ALP and TB. The ethanolic extract showed the most significant hepatoprotective activity comparable with standard drug silymarin. Other extracts namely chloroform and petroleum ether not exhibited any potent activity on hepatic cells [45].

Ixora pavetta

The ethanolic extract of stem bark and leaves of *I. pavetta* (Rubiaceae) against isoniazid and rifampicin induced hepatotoxicity in rats. Liver functions were estimated by the determination of SGPT, SGOT, ALP, total cholesterol, TB and DB. The biochemical analysis results suggest that the use of ethanolic extract of *I. pavetta* exhibited significant protective effect from hepatic damage in against isoniazid and rifampicin induced hepatotoxicity. Histopathological studies revealed that concurrent administration of the extract exhibited a protective effect on the liver. The effects produced were comparable to that of a standard silymarin [46].

Justicia gendarussa

The hepatoprotective activity of the methanolic extract of *J. gendarussa* (Acanthaceae) stems was evaluated by carbon tetrachloride induced liver damage model in rats. In hepatoprotective activity study, carbon tetrachloride significantly increased the levels of SGPT, SGOT and total protein. Pre-treatment of the rats with methanolic extract of *J. gendarussa* inhibited the increase in serum levels of SGPT, SGOT and total protein then inhibition was comparable with silymarin. The present study revealed that the *J. gendarussa* stems have significant hepatoprotective activity [47].

Lagenaria siceraria

Hepatoprotective activity of ethanolic extract of *L. siceraria* (Cucurbitaceae) fruit was reported by inducing hepatotoxicity with

carbon tetrachloride in rats. It show decreasing the serum enzymatic level of ALT, AST, ALP serum protein and TB. The effects produce comparable with standard drug silymarin. Histopathology of the liver sections of the animals treated with the extracts showed the presence of normal hepatic cords. Experimental results revealed that *L. siceraria* fruits possess significant hepatoprotective activity [48].

Lawsonia inermis

Warm aqueous extract of *L. inermis* (Lythraceae) leaves was prepared and tested for its hepatoprotective effect against carbon tetrachloride induced hepatitis in rats. It was studied by estimating serum enzyme activities of SGPT, SGOT, serum AKP (SAKP) and serum bilirubin. The results showed that significant hepatoprotective effects were obtained against liver damage induced by carbon tetrachloride as evidenced by decreased levels of SGPT, SGOT, SAKP and serum bilirubin. The effects produced were comparable to that of a standard silymarin [49].

Lepidium sativum

Hepatoprotective activity of the methanolic extract of *L. sativum* (Brassicaceae) seeds was investigated by the inducing hepatotoxicity with carbon tetrachloride in rats. The extract shows the protective effect by lowering the serum levels of AST, ALT, ALP and bilirubin. The effects produced were comparable to that of a standard hepatoprotective agent [50].

Leucas asper

L. asper (Lamiaceae) is the protective effects of hydroalcoholic extract of leaves against liver damage were evaluated in lead acetate-induced hepatotoxicity in rats. The results showed that the treatment of hydroalcoholic extract of *L. asper* significantly, lowered the serum enzymatic levels of ALT, AST, ALP and bilirubin. The effects produced were comparable to that of a standard silymarin [51].

Mentha arvensis

Hepatoprotective activity of chloroform, ethanol and aqueous extracts of *M. arvensis* leaves (Lamiaceae) against carbon tetrachloride-induced liver damage in rats. In hepatoprotective activity, carbon tetrachloride significantly increased the levels of SGPT, SGOT and serum bilirubin. Pre-treatment of the rats with extracts of *M. arvensis* inhibited the increase in serum levels of SGPT, SGOT, serum protein and inhibition was comparable with silymarin. The present study revealed that the *M. arvensis* stems have significant hepatoprotective activity [52].

Oroxylum indicum

Hepatoprotective activities of petroleum ether, chloroform, methanol and aqueous extracts of *O. indicum* (Bignoniaceae) stem barks were examined against carbon tetrachloride induced liver damage in mice. Shielding effect of *O. indicum* methanolic extract show by lowering the elevated level of SGOT, SGPT ALP, total protein and TB. The effects produced were comparable with standard drug silymarin. Other extracts namely petroleum ether, chloroform and aqueous not exhibited any potent activity on hepatic cells [53].

Pavetta indica

Aqueous extract of *P. indica* (Rubiaceae) leaves evaluated against carbon tetrachloride induce hepatotoxicity in rats. It shows a decrease in the serum enzymatic level of ALT, AST, ALP, total protein and TB. The effects produced were comparable to that of a standard hepatoprotective agent. The results indicated that the *P. indica* leaves possess significant hepatoprotective activity [54].

Perugularia daemia

The hepatoprotective activity of the ethanolic extract of *P. daemia* (Asclepidaceae) aerial parts was evaluated by carbon tetrachloride induced liver damage model in rats. In hepatoprotective activity study, carbon tetrachloride significantly increased the levels of SGPT, SGOT, TB and total protein. Pre-treatment of the rats with ethanolic extract of *P. daemia* inhibited the increase in serum levels of SGPT, SGOT, TB and total protein and inhibition was comparable with silymarin. The present study revealed that the *P. daemia* stems have significant hepatoprotective activity [55].

Phyllanthus amarus

Hepatoprotective activity of aqueous extract of *P. amarus* (Euphorbiaceae) whole plant was reported by inducing hepatotoxicity with ethanol in rats. It shows a decrease in the serum enzymatic level of ALT and AST. The effects produce comparable with standard drug silymarin. Histopathology of liver sections of the animals treated with the extracts showed the presence of normal hepatic cords. Experimental results revealed that *P. amarus* whole plant possess significant hepatoprotective activity [56].

Plumbago zylanica

P. zylanica (Plumbaginaceae) is the protective effects of methanolic extract of aerial parts against liver damage were evaluated in carbon tetrachloride induced hepatotoxicity in rats. The results showed that the treatment of methanolic extract of *P. zylanica* significantly, lowered the serum enzymatic levels of SGPT, SGOT, ALP and TB. Histopathology of the liver sections of the animals treated with the extracts showed the presence of normal hepatic cells. The effects produced were comparable to that of a standard silymarin [57].

Polycarpaea corymbosa

Ethanolic extract of *P. corymbosa* (Caryophyllaceae) whole plant was prepared and tested for its hepatoprotective effect against carbon tetrachloride induced hepatitis in rats. It is known to be assessed by serum enzyme activities of SGOT, SGPT, ALP and TB. The results showed that significant hepatoprotective effects were obtained against liver damage induced by carbon tetrachloride as evidenced by decreased levels of serum enzyme activities of SGPT, SGOT, ALP and TB. The consequences produced were comparable to that of a standard silymarin [58].

Polygonum glabrum

The anti-hepatotoxic effect of *P. glabrum* (Polygonaceae) leaves ethanolic extract was evaluated in the experimental model of liver injury in rats induced by carbon tetrachloride. The Hepatic dysfunction was accessed by determining different biochemical parameters in serum the activities of enzymes like SGPT, SGOT, ALP, total protein, DB and TB were evaluated. The outcome were comparable with standard hepatoprotective agent [59].

Portulaca oleracea

The ethanolic extract of whole plant of *P. oleracea* (Portulacaceae) against carbon tetrachloride induced hepatotoxicity in rats. Liver functions were assessed by the determination of ALP, SGPT, SGOT and TB. The serum biochemical analysis effects suggest that the use of ethanolic extract of *P. oleracea* exhibited significant protective effect from hepatic damage in against carbon tetrachloride induced hepatotoxicity. Histopathological studies revealed that concurrent administration of the extract exhibited a protective effect on the liver. The probable findings produced were comparable to that of a standard silymarin [60].

Raphanus sativus

Hepatoprotective activity of extracted anthocyanins fraction of *R. sativus* (Brassicaceae) root tuber performed against carbon tetrachloride induced hepatotoxicity in rats. Several biochemical parameters like ALT, ALP, TB and DB levels in serum as well as the GSH and malondialdehyde levels in the liver were determined. Histopathological changes also measured. CCl_4 significantly raised the serum level of all biochemical parameters. The pre-treatment of extracted anthocyanins fraction of *R. sativus* reversed the alteration of biochemical parameters toward normal. The activity was compared with the reference drug silymarin [61].

Solanum torvum

S. torvum (Solanaceae) is the protective effects of ethanolic extract of fruits against liver damage were evaluated in carbon tetrachloride

Table 1: List of plants reported for hepatotoxicity

Plant name	Family	Part used	Extract used	Animal model	References
A. precatorius	Fabaceae	Seed	Hydroalcoholic extract	Paracetamol	[7]
A. indicum	Malvacea	Leaves	Aqueous extract	CCl_4*, paracetamol	[8,9]
A. aspera	Amaranthaceae	Seed	Hydroalcoholic extract	CCl_4	[10]
A. procera	Mimosaceae	Aerial parts	Ethanolic extract	Paracetamol	[11]
A. cepa	Alliaceae	Bulbs	Aqueous extract	Cadmium	[12]
A. tricolor	Amaranthaceae	Roots	Aqueous extract	Paracetamol	[13]
A. paniculata	Acanthaceae	Whole plant	Aqueous extract	CCl_4, ethanol	[14,15]
A. carambola	Averrhoaceae	Stems	Ethanolic extract	CCl_4	[16]
A. indica	Meliaceae	Leaves	Hydroalcoholic extract	CCl_4	[17]
B. racemosa	Caesalpiniaceae	Stem bark	Ethanolic, aqueous extract	CCl_4	[18]
B. mollis	Asteraceae	Leaves	Methanolic extract	Paracetamol	[19]
B. diffusa	Nyctaginaceaee	Roots, aerial parts	Hydroalcoholic extract	Ibuprofen	[20]
B. retusa	Euphorbiaceae	Barks	Aqueous, Ethanolic extract	CCl_4	[21]
B. monosperma	Fabaceae	Stem bark	Hydroalcoholic extract	CCl_4	[22]
C. floribumda	Combretaceae	Stem bark	Methanolic extract	CCl_4	[23]
C. indica	Cannaceae	Aerial parts	Methanolic extract	CCl_4	[24]
C. rheedii	Opiliaceae	Whole plant	Ethanolic extract	Paracetamol	[25]
C. tinctorius	Asteraceae	Flowers	Na_2Co_3 extract	CCl_4	[26]
C. fistula	Caesalpinaceae	Seeds	Methanolic extract	Paracetamol	[27]
C. asiatica	Apiaceae	Whole plant	Aqueous extract	CCl_4	[28]
C. colocynthis	Cucurbitaceae	Whole plant	Alcoholic extract	CCl_4	[29]
C. buchananii	Periplocaceaee	Leaves	Ethanolic extract	Acetaminophen	[30]
C. longa	Zingiberaceae	Tubers	Alcoholic extract	Lead	[31]
C. reflexa	Cuscutaceae	Whole plant	Hydroalcoholic extract	Paracetamol	[32]
D. carota	Apiaceae	Root tubers	Methanolic extract	Paracetamol	[33]
D. hamiltonii	Periplocaceae	Root	Methanolic extract	Acetaminophen	[34]
E. viride	Acanthaceae	Root	Methanolic extract	CCl_4	[35]
E. prostrata	Asteraceae	Leaves	Aqueous extract	CCl_4	[36]
E. alba	Asteraceae	Leaves	Aqueous extract	CCl_4, paracetamol	[37,38]
E. hirta	Euphoribaceae	Whole plant	Alcoholic, Aqueous extract	CCl_4, paracetamol	[39]
F. carica	Moraceae	Leaves	Ethanolic extract	CCl_4	[40]
F. indica	Flacourtiaceae	Leaves	Aqueous extract	CCl_4	[41]
F. trinervia	Asteraceae	Whole plant	Methanolic extract	Ethanol	[42]
H. indicus	Periplocaceae	Roots	Methanolic extract	CCl_4, Paracetamol	[43]
H. aromatic	Araceae	Dried rhizomes	Ethanolic extract	CCl_4	[44]
I. barberi	Fabaceae	Aerial parts	Ethanolic extract	D-Galactosamine	[45]
I. pavetta	Rubiaceae	Leaves	Ethanolic extract	Isoniazid and rifampicin	[46]
J. gendarussa	Acanthaceae	Stems	Methanolic extract	CCl_4	[47]
L. siceraria	Cucurbitaceae	Fruits	Ethanolic extract	CCl_4	[48]
L. inermis	Lythraceae	Leaves	Warm aqueous extract	CCl_4	[49]
L. sativum	Brassicaceae	Seed	Methanolic extract	CCl_4	[50]
L. asper	Lamiaceae	Leaves	Hydroalcoholic extract	Lead acetate	[51]
M. arvensis	Lamiaceae	Leaves	Chloroform, ethanol, aqueous extract	CCl_4	[52]
O. indicum	Bignoniaceae	Stem bark	Petroleum ether, chloroform, methanol aqueous extract	CCl_4	[53]
P. indica	Rubiaceae	Leaves	Aqueous extract	CCl_4	[54]
P. daemia	Asclepidaceae	Aerial parts	Ethanolic extract	CCl_4	[55]
P. amarus	Euphorbiaceae	Whole plant	Aqueous extract	Ethanol	[56]
P. zylanica	Plumbaginaceae	Aerial parts	Methanolic extract	CCl_4	[57]
P. corymbosa	Caryophyllaceae	Whole plant	Ethanolic extract	CCl_4	[58]
P. glabrum	Polygonaceae	Leaves	Ethanolic extract	CCl_4	[59]
P. oleracea	Portulacaceae	Whole plant	Ethanolic extract	CCl_4	[60]
R. sativus	Brassicaceae	Root tuber	-	CCl_4	[61]
S. torvum	Solanaceae	Fruits	Ethanolic extract	CCl_4	[62]
T. indicus	Caesalpinaceae	Fruits	Aqueous extract	CCl_4	[44]
T. calophylla	Fabaceae	Root	Methanolic extract	CCl_4	[63]

*Carbon tetrachloride, *A. precatorius: Abrus precatorius, A. indicum: Abutilon indicum, A. aspera: Achyranthes aspera, A. procera: Albizia procera, A. cepa: Allium cepa, A. tricolor: Amaranthus tricolor, A. paniculata: Andrographis paniculata, A. carambola: Averrhoa carambola, A. indica: Azadirachta indica, B. racemosa: Bauhinia racemosa, B. mollis: Blumea mollis, B. diffusa: Boerhavia diffusa, B. retusa: Bridelia retusa, B. monosperma: Butea monosperma, C. floribumda: Calycopteris floribumda, C. indica: Canna indica, C. rheedii: Cansjera rheedii, C. tinctorius: Carthamus tinctorius, C. fistula: Cassia fistula, C. asiatica: Centella asiatica, C. colocynthis: Citrullus colocynthis, C. buchananii: Cryptolepis buchananii, C. longa: Curcuma longa, C. reflexa: Cuscuta reflexa, D. carota: Dacus carota, D. hamiltonii: Decalepis hamiltonii, E. viride: Ecbolium viride, E. prostrata: Eclipta prostrata, E. alba: Eclipta alba, E. hirta: Euphorbia hirta, F. carica: Ficus carica, F. indica: Flacourtia indica, F. trinervia: Flaveria trinervia, H. indicus: Hemidesmus indicus, H. aromatic: Homalomena aromatic, I. barberi: Indigofera barberi, I. pavetta: lxora pavetta, J. gendarussa: Justicia gendarussa, L. siceraria: Lagenaria siceraria, L. inermis: Lawsonia inermis, L. sativum: Lepidium sativum, L. asper: Leucas asper, M. arvensis: Mentha arvensis, O. indicum: Oroxylum indicum, P. indica: Pavetta indica, P. daemia: Perugularia daemia, P. amarus: Phyllanthus amarus, P. zylanica: Plumbago zylanica, P. corymbosa: Polycarpaea corymbosa, P. glabrum: Polygonum glabrum, P. oleracea: Portulaca oleracea, R. sativus: Raphanus sativus, S. torvum: Solanum torvum, T. indicus: Tamarindus indicus, T. calophylla: Tephrosia calophylla*

induced hepatotoxicity in rats. The results showed that the treatment of ethanolic extract of *S. torvum* significantly, lowered the serum enzymatic levels of ALT, AST, ALP, total protein and TB. The effects produced were comparable to that of a standard silymarin [62].

Tamarindus indicus

The protective effect of *T. indicus* (Caesalpinaceae) dry fruits were evaluated in carbon tetrachloride induced hepatotoxicity. The estimation of liver weight and blood parameters consist of serum protein, TB, SGOT, SGPT, ALP and albumin ALT, AST, ALP, total serum protein and TB are performed. This study revealed that the aqueous extract of *T. indicus* (Caesalpinaceae) dry fruits exerted hepatoprotective effect. The effects produced were comparable to that of a standard hepatoprotective agent [44].

Tephrosia calophylla

Methanolic extract of *T. calophylla* (Fabaceae) root was reported by inducing hepatotoxicity with a carbon tetrachloride induced hepatic injury in rats. Protective effect of *T. calophylla* show by lowering the elevated level of SGOT, SGPT, ALP, total protein, albumin and TB. Histopathological studies revealed that concurrent administration of the extract exhibited protective effect on the liver. The results produced were compared with that of the standard drug silymarin [63].

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